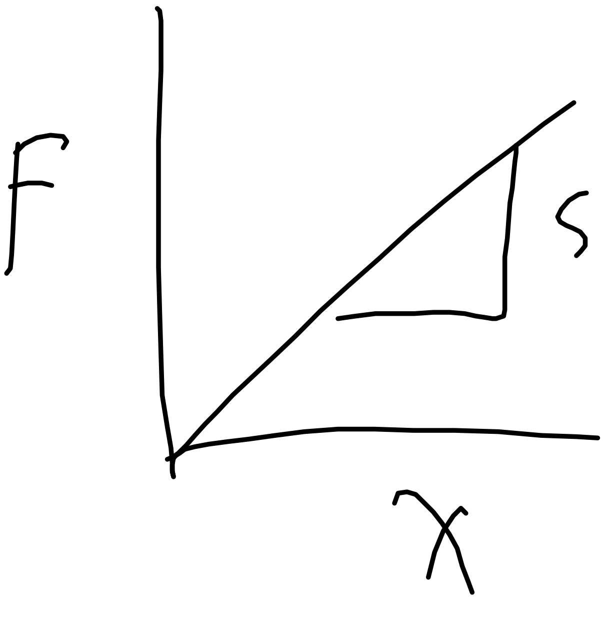
Wednesday, November 22, 2017 8:39 AM

Elastic Forces - not in book
Universal gravity(chap 8.1)
Group Test Friday
Individual Test Tuesday Nov 28
Momentum Thursday Nov 30 - marks

Elastic Lab
You pulled on the elastic band and they stretched a distance, x. What did your graph look like? What was your slope?



slope = $2.2 \frac{N}{cm}$

variable

$y = m x + b$

quantities

$$F = 2.2 \frac{N}{cm} x$$

For a perfectly elastic object, the extension or compression (x) causes an elastic force $F_{elastic}$ opposing the change.

Hooke's Law

$F_{elastic} = -kx$

the negative shows the direction of force is opposite the compression or extension, x.

k is the elastic constant, that depends on the material and shape of the elastic object.

So, if your slope = 2.2N/cm, then that is k for that elastic.

If you pulled that elastic 4.4N of force, how far would it stretch? $x = F/k = 4.4N/2.2N/cm = 2.0cm$ in the direction you pull it.

eg. I pulled an elastic 5.0 cm and it pulled back with 6.0N of force. I pulled a spring 5.0 cm and it pulled back with 3.0N.

a) what is the elastic constant of each item?
b) if I hang a 1.0 kg mass on each, how far will it stretch? (not moving)
c) if I pull the 1.0 kg mass down 2.0 cm more and let go, what is the acceleration of the mass?

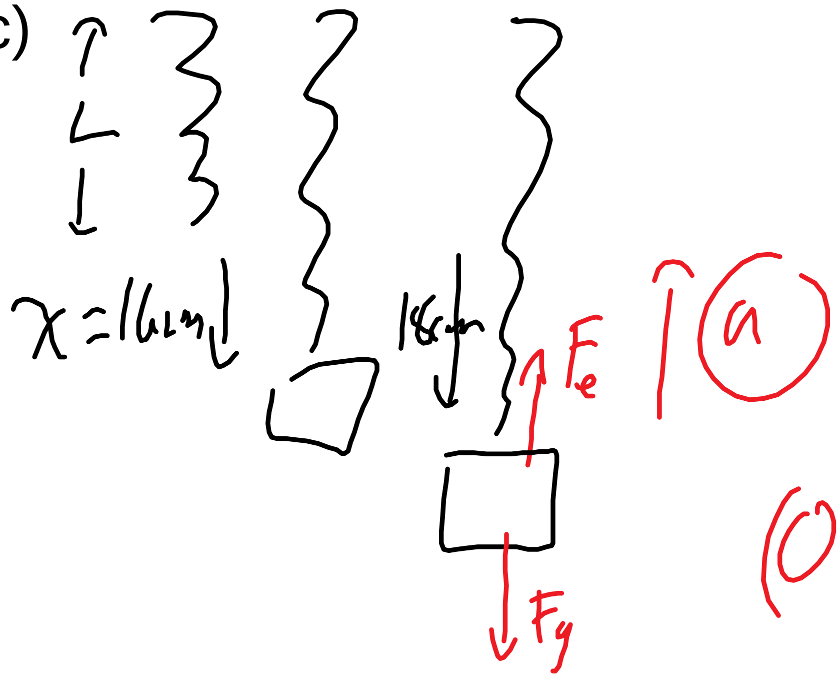
What is gravity?

Newton and the apple.

a) k=F/x = 6N/5cm=1.2 N/cm elastic
3N/5cm=0.60 N/cm spring

b) F_g =mg = 1.0kgx9.80N/kg = 9.8N
x=F/k = 9.8N/1.2N/cm = 8.16cm = 8.2cm
elastic band
9.8/0.6=16.3333 or 16cm spring

c)



$F_{net} = ma = \Sigma F$

$F_e - F_g = ma$

$kx - mg = ma$

$(0.60\frac{N}{cm})(18cm) - 1.0kg(9.8\frac{N}{cm}) = 1.0kg\ a$

a = (0.6x18.333)-9.8=1.2m/s^2
for the spring
(1.2x(8.2+2))-9.8=2.44
2.4 m/s^2 for elastic

Gravity

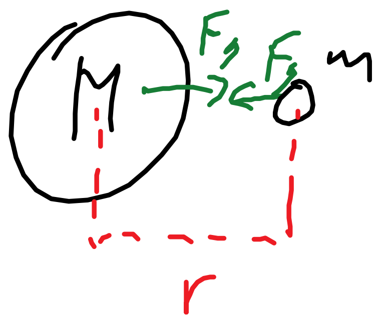
What is gravity?
a force
Near Earth, the gravitational field strength, g, is 9.8 N/kg.
It depends on the mass of gravitational object, for example the Earth.
It also depends on how far are you from the object.

Newton: All objects with mass are pulled together everywhere in the universe.

Einstein: All masses warp space time causing attraction (and slight time warp).

Newton's universal gravitational equation:

$F_g = mg = GMm/r^2$



$g=GM/r^2$

F_g is the gravitational attracting pulling any two masses together.

M and m are any two masses in kg.

r is the distance between the centre of the two

masses, in metres, m.

G is the universal gravitational constant $6.67 \times 10^{-11} Nm^2/kg^2$ everywhere in the universe.

eg. 1. Show that g on Earth is 9.8N/kg given the mass of Earth is 5.98×10^{24}kg and the radius is 6.38×10^6m.

2. What is force on the Earth pulling it towards the sun, if the mass of the sun is 1.98×10^{30}kg and the distance is 1.50×10^{11}m.
3. What is the force attracting a 50.0kg student to a 60.0kg student 1.5 m apart?

1. $g = GM/r^2 = 6.67 \times 10^{-11} Nm^2/kg^2 \times 5.98 \times 10^{24} kg \,/\, (6.38 \times 10^6 m)^2$

= 6.67E-11x5.98E24/((6.38E6)x(6.38E6))=
9.7991 = 9.8 N/kg

equations/givens:
$F_{net} = ma = \sum F$
$F_g = mg = GMm/r^2$
$g = 9.8 N/kg \quad G = 6.67 \times 10^{-11} Nm^2/kg^2$
$F_f = \mu F_N$
$F_e = -kx$
pulley equation - you should work out elevator equation too

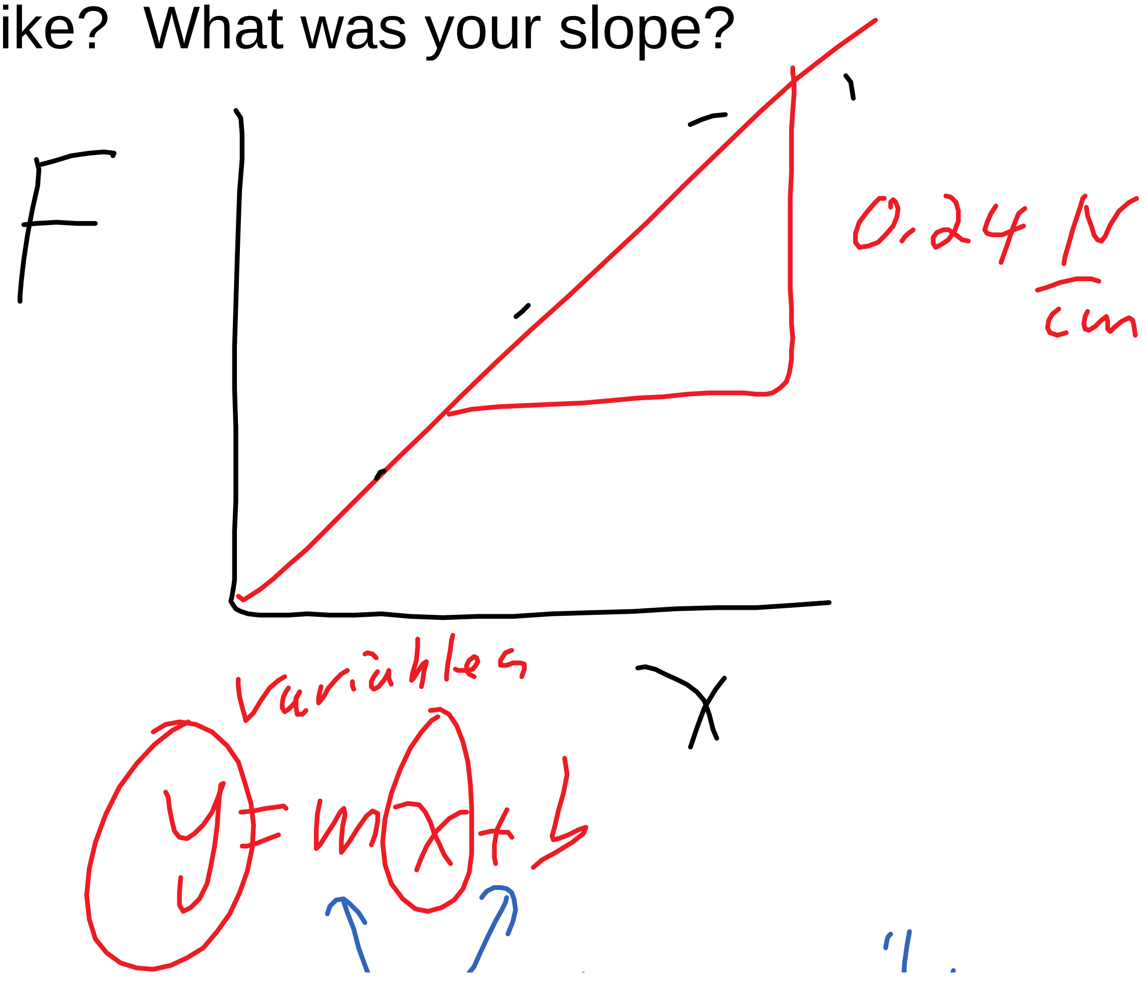
$F_g = mg = GMm/r^2$

6.67E-11x5.98E24x1.98E30/(1.5E11x1.5E11)=
3.51E22
3.51×10^{22}N of force pulling the Earth into the Sun

Block 2-4

Elastic Forces - not in book
Universal gravity(chap 8.1)
Group Test Friday
Individual Test Tuesday Nov 28
Momentum Thursday Nov 30 - marks

Elastic Lab
You pulled on the elastic band and they stretched a distance, x. What did your graph look like? What was your slope?



quantities + units

$$F = 0.24 \frac{N}{cm} x$$

Hooke's Law

For a perfectly elastic object, if you compress or stretch it a distance, x, it will respond with an elastic force, F_e, proportional to x.

$F_e \propto x$
or $F_e = -kx$
where k is the elastic constant, in N/m or N/cm,
k depends on the material and shape of the elastic object.
the negative sign indicates that the object pushes back opposite to x, the stretch.

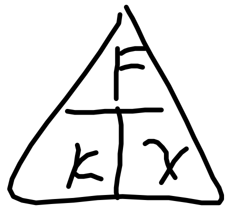
so if k is 0.24N/cm, if I pulled that elastic band with 0.48 N it would stretch 2.0 cm

$F=kx \quad x = F/k = 0.48N/0.24N/cm = 2.0$ cm

eg. I pulled an elastic 5.0 cm and it pulled back with 6.0N of force. I pulled a spring 5.0 cm and it pulled back with 3.0N.

a) what is the elastic constant of each item?
b) if I hang a 1.0 kg mass on each, how far will it stretch? (not moving)
c) if I pull the 1.0 kg mass down 2.0 cm more and let go, what is the acceleration of the mass?

What is gravity?
Newton and the apple.

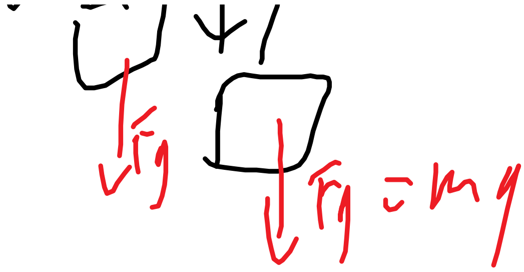


a) F=kx and F=6.0N for the elastic x = 5.0cm
k = F/x = 6/5=1.2 N/cm elastic
3/5=0.6 = 0.60N/cm spring (2 sig figs)

b) F_g = mg = 1.0kg x 9.8N/kg = 9.8N
if a = 0 then F_g = F_e
9.8N = kx
x = 9.8/1.2=8.1667 cm for elastic = 8.2cm
9.8/0.6=16.3333 cm for the spring = 16cm

c) 2 more cm so elastic x = 8.2cm + 2cm = 10.1667cm
for spring x = 16.333+2=18.333 cm

$F_{net} = ma = \Sigma F$
$ma = F_e - F_g$
1kg a = (1.2 x 10.2) − 9.8



$$a = 2.4\ m/s^2$$

$$N = kg\,m/s^2$$

(↑ defined as)

$$1kg\ a = \left(0.60\frac{N}{cm} \times 18.3\,cm\right) - 9.8\,N$$

$$a = 12\ m/s^2$$

Gravity

What is gravity?

Pulls towards the Earth if you are near Earth.

g is the gravitational field strength = 9.8N/kg near Earth.

What if you are not near Earth?

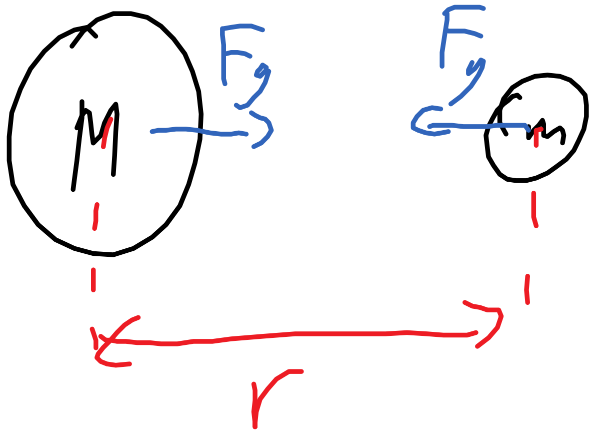
Newton - Saw an apple fall, and thought, "why doesn't the moon fall?"

Answer: the moon falls but moves sideways fast enough to miss the Earth in its fall.

As you move away from the Earth, gravitational pull decreases. The moon has

less mass, so it has a lower gravitational pull than the Earth.

$F_g = mg = GMm/r^2$



F_g is the force of gravity pulling any two masses together, in Newtons, N.
M and m are any two masses, in kg.
r is the distance between the centre of the masses, in metres, m (NOT km)
G is the gravitational constant - the same everywhere in the universe.
value of $6.67 \times 10^{-11} Nm^2/kg^2$

eg. what is g on Earth using Newton's equation and the mass of the Earth is 5.98×10^{24}kg and the radius of the Earth is 6.38×10^6m?
$F_g=mg=GMm/r^2$

$g = GM/r^2$ =
6.67E-11x5.98E24/(6.38E6x6.38E6)=9.7991

9.8N/kg cool

Homework - study

1. What is force on the Earth pulling it towards the sun, if the mass of the sun is 1.98×10^{30}kg and the distance is 1.50×10^{11}m.
2. What is the force attracting a 50.0kg student to a 60.0kg student 1.5 m apart?

Block 2-2

Universal gravity (chap 8.1) go over chapter review problems

Group Test Friday
Individual Test Tuesday Nov 28
Momentum Thursday Nov 30 - marks

Homework
What is the force of gravity pulling

a) two students together, one 50.0 kg and one 60.0kg who are 1.5 m apart?

$F_g=GMm/r^2$

$6.67 \times 10^{-11} Nm^2/kg^2$ x 50.0kgx60.0kg $/(1.5m)^2$

6.67x50x60/(1.5x1.5)=8,893.3333

8.9×10^{-8}N

b) a 1.0kg mass towards the Earth, radius

$6.38x10^6$m with a mass of $5.98x10^{24}$kg.

F_g=GMm/r^2
= 6.67E-11x5.98E24x1/(6.38E6x6.38E6)=
9.7991

x 10^{-11}

= 9.8N

c) the Earth to the Sun, $1.98x10^{30}$kg $1.5x10^{11}$m away.
F_g=GMm/r^2
=
6.67E-11x5.98E24x1.98E30/(1.5E11x1.5E11)
=3.51E22
3.51 x 10^{22} N

Why don't we fall into the sun? Why doesn't the moon fall on our heads?

What is g at the international space station, 400km above the surface of the Earth?

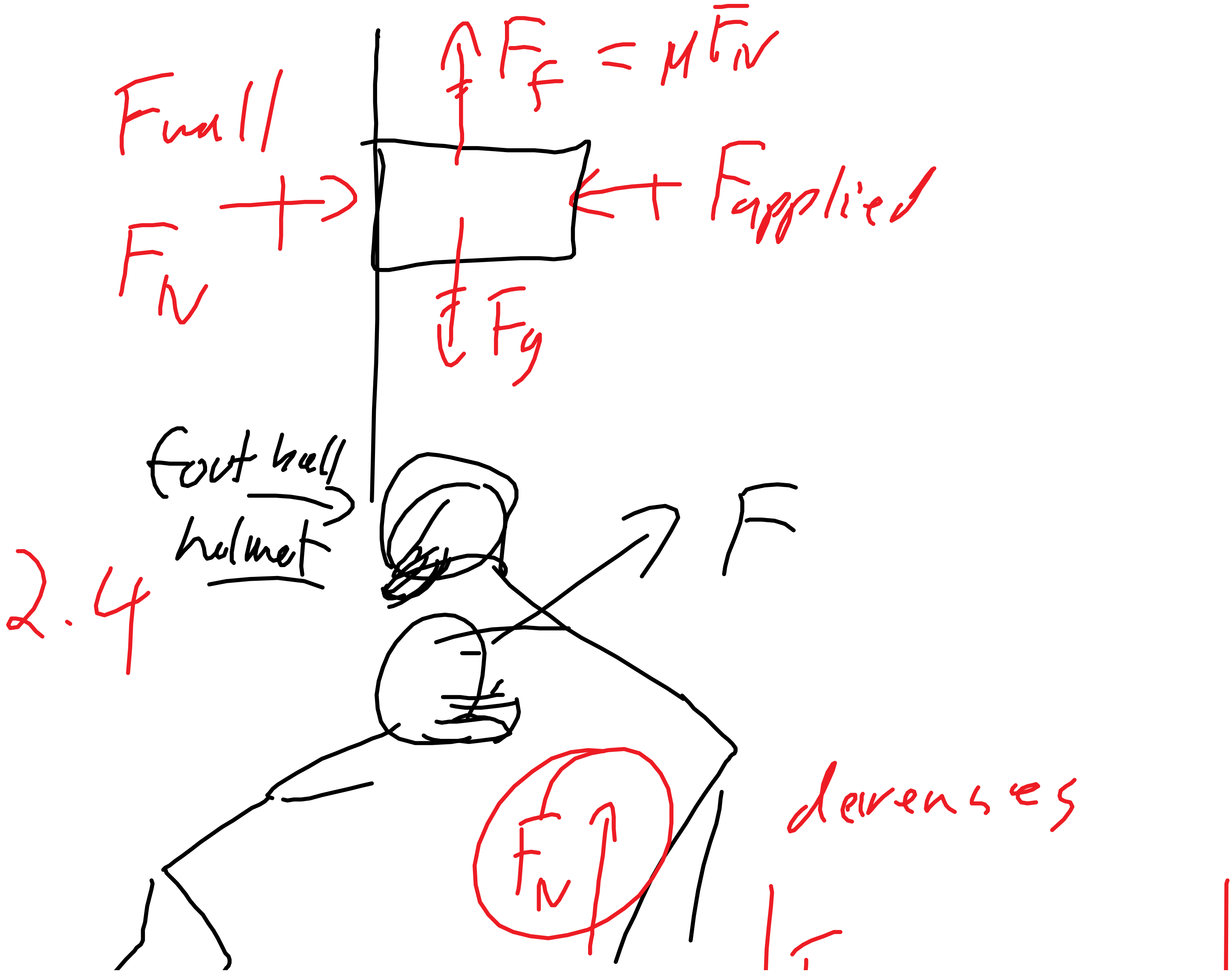
mg=GMm/r^2

g = GM/r^2 6.67E-11x5.98E24/(6.38E6+4E5)^2
=8.677
= 8.7N/kg or 8.7m/s^2
Why do they seem weightless?

p103

CR 2.1 - skydiver a=?
after the parachute opens the skydiver slows down, so they must be accelerating up
once they hit terminal velocity, they don't accelerate

CR 2.2 mass = 115kg $W=F_g$ = mg = 115kgx9.8N/kg = 115x9.8=1,127 N
Fup must be greater than the weight so it can accelerate up.
Fup = Fg if you move it up at a constant speed

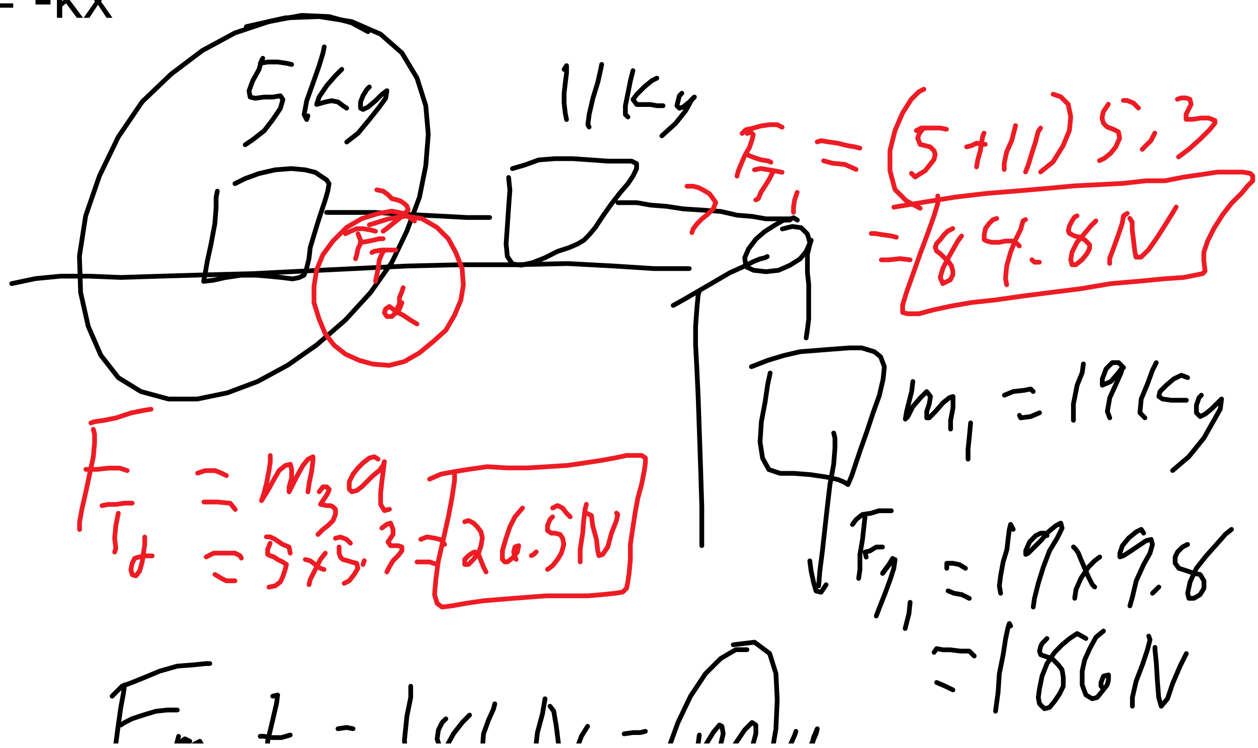


When Flo lifted Roberta, the normal force of the ground on her feet (reading on the scale) decreased.

$F_f = \mu F_N$ so if the normal force is reduced, then the frictional force used to run is reduced and your feet can slip.

equations:

$F_{net} = ma = \sum F$ = Fup-Fdown or Fright - Fleft
F_g = weight = $mg = GMm/r^2$
$g = 9.8$N/kg near Earth $G = 6.67\text{x}10^{-11}\text{Nm}^2/\text{kg}^2$
$F_f = \mu F_N$
$F_e = -kx$



$$a = \frac{186N}{(5+11+19)} = 5.3 m/s^2$$